GROWTH, YIELD AND WATER PRODUCTIVITY OF MEDICINIAL PLANTS UNDER SEASONAL WATERLOGGED ECOSYSTEM

P S Brahmanand*, A Kumar, S Roy Chowdhury, N Sahoo, D K Kundu, S Mohanty and M S Behera

*****Directorate of Water Management (ICAR), Chandrasekharpur, Bhubaneswar, Odisha

psbanand@yahoo.com

ABSTRACT

A field experiment was conducted at Central research farm of Directorate of Water Management, Mendhasal, Odisha, India during post rainy season in 2005-06 to study and evaluate the performance of five medicinal plants i.e. *Coleus forskholii* (coleus), *Eclipta alba* (bringraj), *Eupatorium triplinerve* (water hemp), *Centella asiatica* (Indian pennywort) and *Marsilea quadrifolia* (European waterclover). As per the results obtained in the study, coleus resulted in highest tuber yield (0.898 t ha^{-1}) and bringraj resulted in highest leaf yield (1.46 t ha^{-1}). Intercropping with blackgram *(Phaeolus mungo)* resulted in lesser leaf yield of all medicinal plants compared to sole cropping where as the reverse trend was noticed in Indian pennywort. The nitrogen uptake was found to be higher in coleus and water hemp when intercropped with blackgram where as other three medicinal plants exhibited a reverse trend. The highest gross water productivity (Rs. 13.3 m^{-3}) and net water productivity (Rs. 5.42 m^{-3}) were noticed with coleus followed by that of bringraj in sole cropping.

Keywords : Coleus forskholii, Eclipta alba, Eupatorium triplinerve, Centella asiatica and Marsilea quadrifolia

INTRODUCTION

The crop production in Eastern India in general and Odisha in particular is constrained by waterlogging. Odisha has more than 80,000 ha area under waterlogging where no crop is cultivated in general or deep water rice is grown during kharif season in some portion resulting in lower crop productivity. Remarkable area under this ecosystem comes under seasonal waterlogging where after harvest of rice, the water recedes gradually with in one month and it acts like a medium land situation. However, in seasonal waterlogged areas, the land is kept fallow in general and in some patches, cultivation of blackgram is prevalent whose productivity is very low. Hence, there is a strong need to develop a suitable alternate crop after the harvest of rice in post rainy season under seasonal waterlogged ecosystem.

In the recent times, the cultivation of medicinal plants has been gaining significance due to their higher market value compared to several field crops. For example, *Coleus forskholii (*coleus*)* is highly remunerative as it produces a chemical called "Forskolin (7 beta-acetoxy-8, 13-epoxy-1 alpha, 6 beta,9 alpha-trihydroxy-labd-14-ene-11-one)" which is used for curing cardio vascular diseases. It is also used to cure respiratory problems, glaucoma, psoriasis, hypothyroidism and weight loss (Godard *et al*., 2005). Similarly, it was also reported that the alcoholic extract of the roots of Coleus forskholii produce caffeic acid and a new monoterpene glycoside, coleoside, characterised as cuminyl-*O*-â-D-glucopyranosyl(1 '! 2)-â-D-galactopyranoside (Ahmed and Vishwakarma, 2001).

It can survive well under wide range of conditions. Though it is a perennial crop, it can be cultivated for production of tubers in both kharif and rabi seasons. In the present study, it was grown during post rainy season with out subjected to water stagnation. Similarly, *Eclipta alba (*bringraj*), Eupatorium triplinerve (*water hemp*), Centela asiatica (*Indian pennywort*)* and *Marsilea quadrifolia (*European waterclover*)* also have significant demand in the market due to their medicinal properties. The juice extracted from leaves of bringraj help in stimulation of brain and hence used in hair tonics alongwith brahmi (Chopra *et al*., 1955). It is also used against anemia, dysentery, eye diseases, asthma and liver cirrhosis. The juice of bringraj together with honey, is used to treat upper respiratory congestion in children.

Leaves of water hemp are sudorific, tonic, febrifuge, alterative, stomachic and antiscorbutic in nature. In addition they also exhibit Antitussive, anticoagulant, depurative, cicatrizant, antitumorous and antiseptic properties (Kokate, 1971). The juice extracted from leaves of Indian pennywort is used in hair oils as it improves memory (Brinkhause and Lindner, 2000). At the same time, it contains steroids which are used to treat leprosy (Hausen, 1993). *Centella asiatica* also has anti-oxidant properties. The extract derived from leaves of European waterclover is anti-inflammatory, diuretic, depurative, febrifuge and refrigerant in nature. Some of these medicinal plants may survive well under seasonal waterlogged condition under post rainy season and hence these can be tested as alternate crops. Keeping this in view, a field experiment was conducted to evaluate the performance of five medicinal plants i.e. *Coleus forskholii* (coleus), *Eclipta alba* (bringraj), *Eupatorium triplinerve* (water hemp), *Centella asiatica* (Indian pennywort) and *Marsilea quadrifolia* (European waterclover) under two different irrigation schedules. Their performance was assessed under both intercropping (with blackgram) and sole cropping.

MATERIALS AND METHODS

Plant material

The seedlings of all the five medicinal plants were raised in nursery during November to December 2005. The seedlings / cuttings were planted after the harvest of kharif rice in post rainy season during January 2006. The cuttings of coleus were drenched in solution of Carbendazim (0.1%) to prevent the fungal diseases.

Experimental design and treatments

The field experiment was laid out using split plot design with two main plot treatments (irrigation scheduling : M1:Irrigations at two critical stages and M2: Irrigation at one critical stage) and 11 sub plot treatments (medicinal crop or inter cropping combination: S1: *Coleus forskholii* S2: *Eclipta alba* S3: *Eupatorium* S4: *Centela asiatica* S5: *Marsilea quadrifolia* S6: Black gram S7: S1+S6 intercropping S8: S2+S6 intercropping S9: S3+S6 intercropping S10: S4+S6 intercropping and S11: S5+S6 intercropping). The plot size was maintained at 5x4 m. No water stagnation was experienced during experimental period. The crops were irrigated as per the treatments. Split plot design was preferred for obtaining higher accuracy in comparison of sub plot treatments.

Growth measurements

The plant biometrical observations like plant height, plant population and dry matter accumulation were recorded for all the five medicinal plants. The final leaf yield and tuber yield (in case of coleus) were recoded at maturity and the pod yield of black gram was also recorded. Modified Microkjeldhal method was followed for analysis of nitrogen in plant samples (Piper, 1966). The nitrogen uptake was computed from nitrogen % and dry matter accumulation. The net returns were calculated by subtracting cost of cultivation from gross returns.

Statistical analysis

All the data collected in the study were analyzed statistically following the analysis of variance procedure described by Gomez and Gomez (1984) for the split plot design adopted in this study. Statistical significance was tested by applying F-test 0.05 level of probability. Critical difference at 0.05 probability level were worked out for the effects that were significant ($P<0.05$).

RESULTS AND DISCUSSION

Effect on growth parameters

The soil is low in organic matter (0.31%), nitrogen and phosphorus and high in potassium. The plant population and plant height at 60 days after planting have shown significant improvement with irrigation at two critical stages than that of single stage irrigation (Table 1). It was also observed that the jump in dry matter accumulation is not found to be statistically significant. The leaf area index of the medicinal plants has shown a slight increase when two irrigations are given compared to that of single stage irrigation, however it is not found to be statistically significant. Among the medicinal plants, the highest plant height was recorded with Eupatorium followed by that of Coleus. However, the highest dry matter accumulation of 662 g m^{-2} has been recorded with Coleus followed by that of bringraj (367 g m^{-2}). The lowest leaf area index of 0.98 was noticed with *Marsilea* (under inter cropping) and the highest value (2.12) was noticed with coleus (inter cropping). However the increase in LAI noticed at intercropping recorded with coleus and eupatorium is not found to be statistically significant.

Table 1 : Plant population m^{-2}, plant height (cm) and dry matter accumulation (g m^{-2}) of medicinal plants at 60 DAP as influenced by irrigation and intercropping with blackgram

	Plant Population m^{-2}			Plant height (cm)			Dry matter accumulation (g m^{-2})		
Treatment	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
S1	3.3	3.3	3.3	28.6	28.6	28.6	665.0	658.3	661.6
S1	3.3	3.3	3.3	28.6	28.6	28.6	665.0	658.3	661.6
S2	10.3	10.0	10.1	17.6	18.3	18.0	391.0	343.6	367.3
S3	5.0	4.6	4.8	13.0	12.6	12.8	202.3	194.3	198.3
S4	4.3	4.0	4.1	33.0	32.3	32.6	261.6	252.6	257.1
S5	10.3	9.3	9.8	12.3	12.6	12.5	159.0	151.6	155.3
S6	31.0	28.0	29.5	34.3	31.6	33.0	465.6	450.0	457.8
S7	3.6	3.3	3.5	28.3	27.3	27.8	685.0	669.0	677.0
S8	5.6	5.6	5.6	18.6	17.6	18.1	218.0	212.0	215.0
S9	4.3	3.6	4.0	12.6	12.3	12.5	207.0	195.6	201.3
S10	4.0	3.6	3.8	34.3	34.0	34.1	258.3	249.0	253.6
S11	5.3	5.3	5.3	12.0	12.0	12.0	86.6	82.6	84.6
Mean	7.9	7.3	7.6	22.7	21.7	22.0	327.2	314.4	320.8
CD (0.05) for Main plot	0.13	0.56	12.9						
CD (0.05) for Sub Plot	1.01	3.86	25.3						
CD (0.05) for Sub plot at same main plot			1.43	5.46	35.8				
CD (0.05) for Main plot at same sub plot			1.37	5.25	35.9				

Effect on economic yield

Among all the five medicinal plants, *Coleus forskholii* proves to be the best performer in terms of crop growth rate and economic yield due to higher drymatter accumulation and leaf area index. It recorded an economic yield of 0.898 t ha^{-1} (Table 2) with a net return of Rs. 19,520/- ha^{-1}.

Bringraj *(Eclipta alba*) has resulted in the second highest crop growth performance. It resulted in the economic yield of 1.46 t ha^{-1} with a net profit of Rs. 9,300/- ha^{-1}. The performance of *Eupatorium*, *Centella asiatica* and *Marsilea quadrifolia* was not found to be satisfactory compared to their average expected yields. This might be due to the heavy weed infestation in the initial stages of crop growth.

Table 2 : Economic yield (tuber/leaf / pod) of medicinal plants at maturity as influenced by irrigation and intercropping, Post rainy season, 2006

Treatment	Economic yield (q/ha) Leaf/Tuber/Pod
Main plot	
M1	6.39
M2	6.15
CD (0.05)	NS
Sub plot	
S1	8.98
S2	14.6
S3	2.15
S4	4.75
S5	3.6
S6	5.3
S7	8.93 + 2.2
S8	12.2 + 2.6
S9	1.95 + 2.7
S10	4.9 + 2.8
S11	2.15 + 2.2
CD (0.05)	1.2

Effect on nitrogen uptake

It was also noticed that the intercropping resulted in higher nitrogen uptake (Fig. 1) in coleus and eupatorium where as it has shown reverse trend in marsilia, centela and eclipta. The reason might be due to higher weed growth noticed in case of coleus and eupatorium under sole cropping. Eclipta by its aggressive spreading nature has not allowed weed growth even in sole cropping.

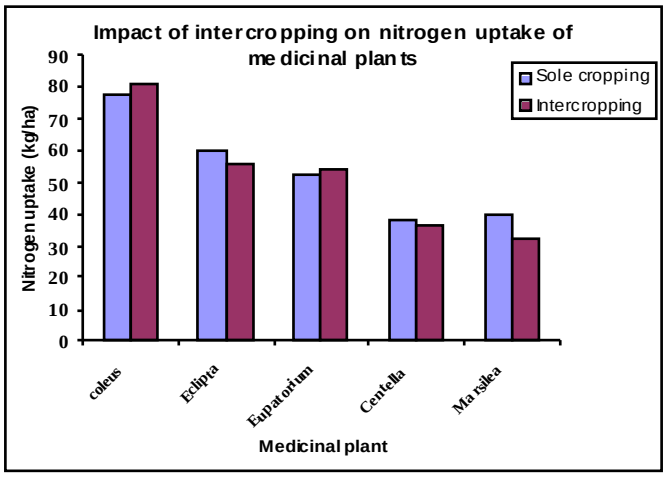

Fig 1 : Impact of intercropping on nitrogen uptake of medicinal plants under seasonal waterlogged condition in post rainy season

Effect on water productivity

The highest gross water productivity (Rs. 13.3 m^3) and net water productivity (Rs. 5.42 m^3) were noticed with coleus followed by that of bringraj in sole cropping (Fig 2). Similar trend was also noticed in intercropping.

Overall, *Coleus forskholii* + blackgram intercropping resulted in the highest economic returns than that of other treatments. Hence, it can be concluded that Coleus as sole crop, bringraj as sole crop and their intercropping with blackgram are found to be the viable options for seasonal waterlogged areas in post rainy season.

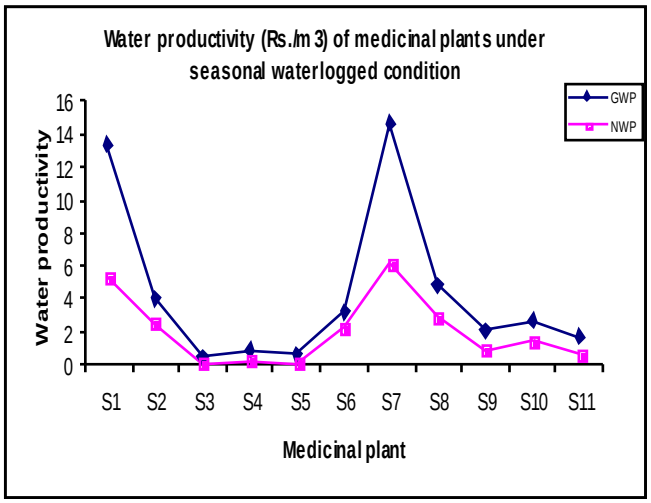

Fig 2 : Water productivity of medicinal plants under seasonal waterlogged condition, Post rainy season.

ACKNOWLEDGEMENT

The authors are very much thankful to the Director, WTCER, Chandrasekharpur, Bhubaneswar for extending his kind support and facilities.

REFERENCES

Ahmed B and Vishwakarma RA (1988) Coleoside, a monoterpene glycoside from *Coleus fprskholii;* Phyto Chemistry, 27 (10) : 3309-3310.

Brahmanand P S and Kannan K (2006) Prospects of medicinal plants of Orissa; Journal of Indian Institute of Public Administration, Special volume on Agriculture, 14 : 499-504.

Brinkhause B *et al.*, (2000) "Chemical, pharmacological and clinical profile of the east Asian medical plant *Centella asiatica*"; Phytomedicine, 7(5) : 427-48.

B M Hausen (1993) "*Centella asiatica* (Indian pennywort), an effective therapeutic but a weak sensitizer;" Contact Dermatitis, 29 (4), 175–179.

Chopra RN, Nayar SL and Chopra IC (1955) Glossary of Indian Medicinal plants, C.S.I.R., New Delhi.

Gomez K A and Gomez AA (1984) Statistical procedures for agricultural research workers, Wiley Interscience publication, John Wiley and Sons., New York.

Godard MP, Johnson BA and Richmond SR (August 2005) "Body composition and hormonal adaptations associated with Forskolin consumption in overweight and obese men"; Obesity Research, 13 (8)

Kokate CK (1971) "Pharmacological studies on the essential oil of *Eupatorium triplinerve*, effects on the central nervous system and antimicrobial activity."; *Flavour*, 1971 ; 2 (3): 177-180.

Piper CS (1966) Soil and plant analysis; Inter Science Publication, New York.